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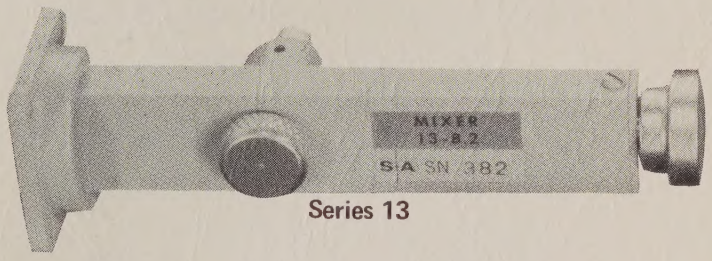
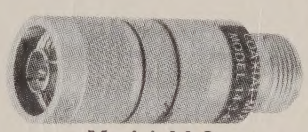
Instruction Manual

P.O. 6-164932

Microwave And Millimeter Wave Mixers



Series 13



Model 14-3

Scientific-Atlanta

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SERIAL NO. _____

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MICROWAVE AND MILLIMETER WAVE MIXERS

For Use With Scientific-Atlanta Instrumentation Receivers

SCIENTIFIC-ATLANTA, INC.
P. O. Box 13654, Atlanta, Ga. 30324

Third Edition
April 1970

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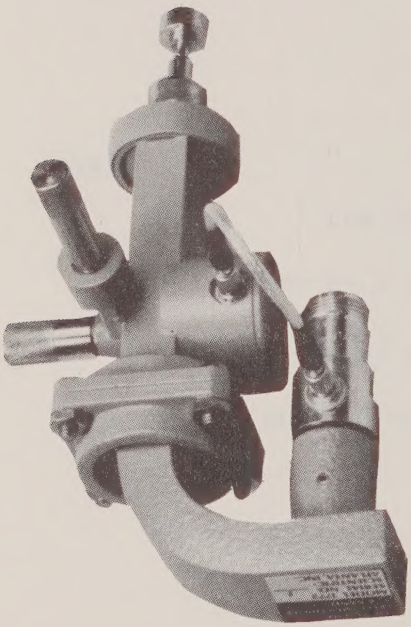

SERIES 17

MODEL 14-3

SERIES 13

FIGURE I-0. REMOTE MIXERS

CHAPTER 1
REMOTE MIXERS

1.1 GENERAL

External mixers or low-frequency converters must be used with Scientific-Atlanta instrumentation receivers. Low-frequency converters are used over the low-frequency range listed in Table 1. External mixers are used over the first local oscillator or higher frequency range.

Table 1 Local-Oscillator Frequency Range and Power Level

Receiver	Low-Frequency Range	First LO Frequency Range	Minimum Available LO Power Per Channel
1710/20	20 MHz - 940 MHz	0.985 - 2.5 GHz	+27 dBm
1740	100 MHz - 2.0 GHz	2.0 - 4.1 GHz	+17 dBm (Reference Channel)
			+23 dBm (Signal Channel)
1750	100 MHz - 2.0 GHz	2.0 - 4.1 GHz	+17 dBm
1630/40	20 MHz - 1.95 GHz	2.0 - 4.1 GHz	+25 dBm

Series 1740 and 1750 receivers require the use of one mixer per channel, see the receiver instruction manual for specific mixer requirements. Indentical mixers are not required.

For best performance use only the following recommended mixers:

a. Scientific-Atlanta Model 14-2 Mixer
b. Scientific-Atlanta Model 14-3 Mixer
c. Scientific-Atlanta Series 13 Tunable Waveguide Mixers
d. Scientific-Atlanta Series 17 Millimeter-Wave Mixers

The Model 1767 Mixer-IF Impedance Matching Network matches the output impedance of the mixer diode to the 50Ω transmission-line impedance at an intermediate frequency of 45 MHz. The network should be used only with Scientific-Atlanta Series 13 and Model 14-2 mixers, see Chapter 2.

1.2 MODEL 14-2 MIXER

The Model 14-2 Mixer is a versatile, broadband coaxial mixer requiring minimum (< +10 dBm) local-oscillator power for operation over the 1.96- to 16.0-GHz frequency range. Sensitivity of this mixer is typically 2 to 5 dB less than that of Series 13 Mixers.

The Model 14-2 Mixer, a shunt mixer, is suitable for broadband operation with long mixer-to-receiver cable lengths. Because of the shunt diode configuration, isolation between the local oscillator and signal input ports is low and the local-oscillator drive level is affected by the source impedance of the antenna or other driving source. Therefore, this mixer is not recommended for making comparative gain measurements between different antennas or other signal sources unless the input is buffered by isolators and/or attenuators. See paragraph 1.6.

1.3 MODEL 14-3 MIXER

The Model 14-3 Coaxial Mixer is a versatile broadband coaxial mixer for operation over the 940-MHz-to-15-GHz frequency range. It requires less than +10 dBm local oscillator power up to 2.5 GHz and less than +15 dBm to 4.1 GHz. The sensitivity of this mixer from 1.0 to 12.4 GHz is comparable to that of the Series 13 Mixers.

The Model 14-3 Coaxial Mixer is a series-diode mixer and is well suited for broadband operation with moderate mixer-to-receiver cable lengths. Because of the series-diode configuration, the isolation between the local oscillator signal and the signal input

port is better than for the Model 14-2. It is recommended that this mixer be buffered by the use of isolators and/or attenuators on the input port. See paragraph 1.7.

1.4 SERIES 13 TUNABLE WAVEGUIDE MIXERS

Series 13 Mixers require moderate local-oscillator drive-power levels (typically < +10 dBm), have good local-oscillator-to-signal-input isolation, and generally yield higher sensitivities than coaxial mixers. Consequently, these mixers can be used with long mixer-to-receiver interconnecting cables and for general-purpose signal-level or gain comparisons which requires the mixer be switched from one source to another.

SPECIFICATIONS

Characteristics / Model No.	13A-2.6	13A-3.9	13A 5.8	13A-8.2	13A-12	13A-18	13A-26	13-A-33	13A-50	13A-60
Freq Range GHz	2.60 to 3.95	3.95 to 5.85	5.85 to 8.20	8.20 to 12.4	12.4 to 18.0	18.0 to 26.5	26.5 to 40.0	33.0 to 50.0	50.0 to 75.0	60.0 to 90.0
Crystal Type (or equivalent)	1N21C	1N21C	1N23C	1N23C	1N78	1N26	1N53	1N53	1N53	1N53
Flange Type	UG-53/U	UG-149/U	UG 344/U	UG-39/U	UG-419/U	UG-425/U	UG-381/U	UG-383/U	UG-385/U	UG-387/U
Flange Geometry	rd.	rd.	rd.	sq.	sq.	rd.*	rd.*	rd.	rd.	rd.
Waveguide (internal size)	2.84 x 1.34	1.87 x 0.87	1.37 x 0.62	0.90 x 0.40	0.62 x 0.31	0.42 x 0.17	0.28 x 0.14	0.22 x 0.11	0.15 x 0.07	0.12 x 0.06

*Square flanges (UG-595/U and UG-599/U) are available upon request.

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1.5 SERIES 17 MIXERS

Series 17 Crystal Mixers, when used with Model 1772 Local-Oscillator Frequency Multipliers, provide sensitivity improvement of 9 to 15 dB over that of conventional harmonic mixers. Sensitivity improvement is achieved by:

1. pre-multiplication of the local-oscillator frequency from S-band to X-band in a Model 1772 Local-Oscillator Frequency Multiplier (this effectively reduces the harmonic mixing number by a factor of 3);
2. using selected mixer diodes;
3. a built-in IF impedance matching network;
4. and dependable, easy-to-set RF tuning adjustments.

The Model 1772 Local-Oscillator Frequency Multiplier is removable from the Series 17 Crystal Mixer; therefore, only one multiplier is required for all five Series 17 Crystal Mixers. The compact Model 1772 includes filters, matching networks, and a built-in frequency-selective tee to enable connection directly to a Scientific-Atlanta Series 1740 or 1630/40 Wide Range Receiver or a Series 1750 Phase/Amplitude Receiver. These mixers cannot be used with the Series 1710 Receivers.

Two types of Series 17 Crystal Mixers are available. One is designed to operate with receivers equipped with a 65-MHz IF amplifier (Series 1600 and Series 402). The other operates with the Series 1740 and 1750 Receivers which have a 45-MHz IF amplifier system.

The 2-to-4 GHz receiver local oscillator output is coupled by a coaxial cable to a Model 1772 Frequency Multiplier. This signal is fed through a frequency-selective tee that is built into the Type N input connector. The S-band signal is converted to X-band by the frequency multiplier. The output of the frequency multiplier is filtered to eliminate the fundamental local oscillator signal

and unwanted harmonics, then waveguide-coupled to a Series 17 Crystal Mixer. All Series 17 Crystal Mixers (with the exception of Model 17-8.2) are crossguide-coupled mixers. Model 17-8.2 is a hybrid balanced-mixer. Precision lead-screw type tuning plungers are used in both waveguide sections for accurate and simple tuning. See Chapter 3 for adjustment procedure.

When using the Series 17 Millimeter-Wave Mixers, it is necessary to deliver a minimum power level of 150 mW (+11.8 dBm) to the input port of the Model 1772 Local-Oscillator Frequency Multiplier. The allowable cable loss can be determined from the available local-oscillator power given in Table 1.

SPECIFICATIONS

Local Oscillator Frequency Multiplier- Model 1772

Input Freq	2.66 to 4.1 GHz
Output Freq to Crystal Mixer	8.2 to 12.4 GHz
Min required power at input of multiplier	150 mW
Max input power	1W

Series 17 Mixers

	MODEL				
45 MHz IF	*17-8.2	17-26-45	17-33-45	17-50-45	17-60-45
65 MHz IF	*17-8.2	17-26-65	17-33-65	17-50-65	17-60-65
Freq Range(GHz)	8.2-12.4	26.5-40.0	33.0-50.0	50.0-75.0	60.0-90.0
Crystal Type	Matched Pair MA-4900 EMR	1N53C	1N53C	1N53C	1N53C
Flange Geometry	UG-39/u Square	UG-381/u Round	UG-383/u Round	UG-385/u Round	UG-387/u Round
Effective Harmonic No.	1	3 & 4	3,4 & 5	5,6, & 7	5,6, 7 & 8

*Modified Microwave Associates Model MA1118B-1BE OrthoTee® Hybrid Balanced Mixer and Special Cable

1.6 VIDEO CRYSTAL HOLDERS

Commercially available video detectors generally are not suitable for use with Scientific-Atlanta instrumentation receivers. Most of these detectors have large capacitance values at the video output connector. These large-capacitance video crystal holders, when used as mixers with an instrumentation receiver, effectively short-circuit the local-oscillator signal at one or more frequencies within the tuning range and load the IF output. The latter results in improper matching of the mixer to the 50Ω coaxial line.

1.7 ISOLATION

When the mixer is to be transferred from one RF energy source to another for purposes of measuring gain or loss by a substitution method, the Series 13, the Series 14-3, or the Series 17 Mixers are recommended. The source impedance to the local-oscillator frequency will generally change causing the mixer crystal current to change when the energy source is changed unless the input is heavily padded or isolated.

Note that when harmonic mixing is employed the local oscillator and signal frequencies are in different bands. If an isolator is used, it must pass the signal frequency and isolate the fundamental local-oscillator signal from the RF input.

An additional reason for padding the RF input to the mixer is to provide the proper load impedance to the RF source.

CHAPTER 2
MIXER MATCHING NETWORK

The Model 1767-IF-Mixer Matching Network provides matching of the output impedance of the mixer diode to a 50Ω line impedance at a center IF frequency of 65 or 45 MHz. The network should be used only with Scientific-Atlanta Series 13 and Model 14-2 Mixers.

Use the Model 1767-65 with the Series 1630/1640 Receiver and the Model 1767-45 with the Series 1700 Receivers.

The network should be connected directly to the coaxial or waveguide mixer output connector. The type N female output connector of the network is then connected to the receiver by means of a coaxial cable having a type N male connector.

The Model 1767 is adjusted for the proper match by turning the knurled ring on the mixer matcher. When using the 1600, 1710, or bolometer-mode 1740 receiver this adjustment is made for an overall flat noise response as observed on the receiver indicator. This adjustment may be made for a zero (center-scale) reading on the AFC meter with the AFC switched off and with the first local-oscillator frequency and power adjusted for best reception but with no input signal. With the 1750 or phase-locked 1740 receiver, the mixer matcher can be adjusted for maximum signal as observed on the amplitude meter of the receiver, although this adjustment is not critical and does not effect the sensitivity of the phase-locked receivers appreciably.

CHAPTER 3
SERIES 17 MIXER ADJUSTMENT

3.1 GENERAL INFORMATION

The four Series 17 Millimeter-Wave Mixers must be used with the Model 1772 Local-Oscillator Frequency Multiplier. The single Model 1772 may be connected to the X-band local-oscillator input of any of the Series 17 Millimeter-Wave Mixers listed in paragraph 1.5.

To provide best sensitivity, use only 1N53C mixer diodes in this mixer. Unselected 1N53 diodes can reduce sensitivity by 10 dB or more.

3.2 INSTALLATION

The Series 17 Mixer and Model 1772 Local-Oscillator Frequency Multiplier assembly is connected to the input of the receiver using a 50Ω coaxial cable. One hundred fifty mW (+11.8 dBm) of local oscillator power is required at the input to the frequency multiplier. The cable is attached to the female type N connector of the local-oscillator frequency multiplier. The short miniature coaxial cable provided must be connected between the female coaxial connectors located on the local-oscillator frequency multiplier and the Series 17 Mixers.

The final digits of the model number of Series 17 Mixers denote the IF center frequency of the matching network. When using the Series 1630/1640 Receivers use only Series 17 Mixers having "65" as the final two digits. When using the Series 1740 or 1750 Receiver, use only Series 17 Mixers having "45" as the final two digits.

It is important first, that the proper mixer be selected to achieve best sensitivity at a particular millimeter-wave frequency. Because the frequency ranges of the four mixers overlap, a choice of which of two mixers should be used for a particular frequency is encountered. The following table will provide assistance in selecting the proper mixer for best sensitivity.

FREQUENCY	RECOMMENDED MIXER
8.2 to 12.4 GHz	Model 17-8.2-45 or -65
26.5 to 36 GHz	Model 17-26-45 or -65
36.0 to 50 GHz	Model 17-33-45 or -65
50.0 to 60 GHz	Model 17-50-45 or -65
60.0 to 90 GHz	Model 17-60-45 or -65

The local-oscillator frequency that must be selected for the input to the local-oscillator frequency multiplier to enable the best sensitivity to be achieved at a particular received frequency will not necessarily be the same as for other mixers. This is because the S-band frequency is tripled to X-band before introduction to the mixer. See the tuning chart in Figure 3-1 for the proper receiver local-oscillator frequency to use with Series 17 Mixers.

3.3 ADJUSTMENTS

The procedure for tuning Series 17 Mixers differs from that normally used to tune Series 13 Mixers. Unless a specific order of adjustment is followed, the optimum sensitivity cannot be obtained.

Series 17 Mixers each have tuning adjustments as follows:

a. A spring-loaded millimeter-wave tuning plunger for matching the mixer diode to the millimeter-wave signal source.

b. A spring-loaded crystal-position depth adjustment to enable the crystal to be positioned for best sensitivity.

c. A spring-loaded crystal adjustment located on the end of the crystal cap to enable the crystal to be rotated about its axis without changing crystal insertion. The axial position of the crystal will influence attainable sensitivity over the millimeter-wave frequency range particularly at the higher frequencies (50 GHz and above).

d. An X-band tuner located at one end of the local-oscillator input waveguide section. This tuner enables optimum matching of the mixer crystal to the X-band impedance of the local-oscillator frequency multiplier. The local-oscillator frequency multiplier is an untuned broadband multiplier, and the X-band output level is below 5.0 mW. Because the X-band local-oscillator power is low, Series 17 Mixers are designed for a minimum of the local-oscillator signal. During operation, typical crystal currents will be in the range of 0.5 to 5.0 mA.

The procedure for tuning the Series 17 Mixers is as follows:

a. Insert the 1N53C crystal to the stop in the crystal retainer and screw the crystal cap on the mixer until the stop is reached. Unscrew the cap approximately 1/32 inch from the stop position.

b. Tune the receiver to the proper local-oscillator frequency as shown in Figure 3-1.

c. Adjust the X-band tuner on the mixer for maximum crystal current. The tuner has both a coarse adjustment with a lock and a spring-loaded fine-tuning adjustment. The range of the fine-tuning adjustment is 1/4 inch from the fully clockwise stop. Before adjusting the coarse-tuning position, set the fine-tuning adjustment approximately 1/8 inch from the fully clockwise position.

d. Apply a strong signal to the signal input of the mixer and tune the receiver for a signal indication. As the mixer is tuned, the signal level may be reduced to avoid receiver saturation.

e. Adjust the millimeter-wave tuner for maximum signal level.

NOTE

Signal-level peaks may occur at more than one plunger position. Select the highest peak.

f. Adjust the depth and axial position of the crystal for maximum signal.

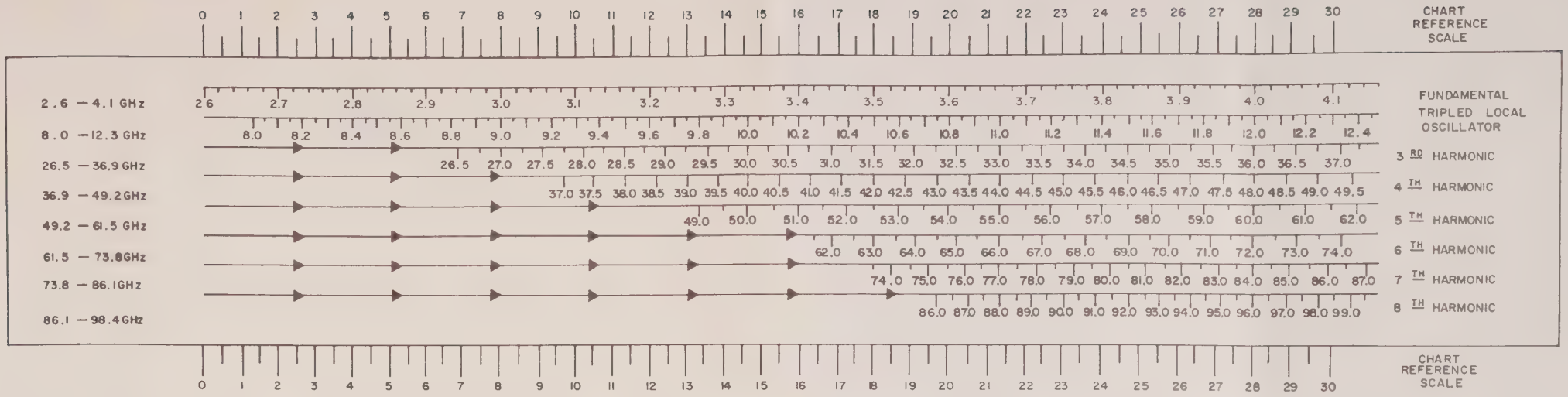
NOTE

Signal-level peaks may occur at more than one crystal depth. Select the highest peak. The position of the crystal plunger must remain within 3/16 inch of the clockwise stop.

g. Carefully adjust the fine-tuning knob on the X-band tuner for maximum signal level. The maximum signal level will not be necessarily the point of maximum crystal current. A crystal current of 0.5 mA or more is desirable.

h. Carefully repeat steps e, f, and g for maximum signal level. The mixer will now be tuned. If the mixer sensitivity appears low, substitute another new 1N53C crystal and repeat the tuning procedure.

This completes the adjustment procedure for the Series 17 Mixers.



INSTRUCTIONS

a. Use this chart only when the receiver is being used with a Series 17 Mixer and Model 1772 Local-Oscillator Frequency Multiplier Assembly.

b. Locate the range in the left column (26.5 to 98.4 GHz) that includes the operating frequency.

c. Locate the operating frequency on the corresponding horizontal scale.

d. Note the frequency on the FUNDAMENTAL scale directly above that corresponds to the operating frequency. Use the CHART REFERENCE SCALES to help align a straight-edge.

e. Tune the receiver to the FUNDAMENTAL frequency found in step d. Use the FUNDAMENTAL scale on the receiver tuning dial.

NOTE

The frequency shown on the second scale (TRIPLED LOCAL OSCILLATOR) is the actual local-oscillator signal applied to the mixer.

FIGURE 3-1. TUNING CHART FOR SERIES 17 MIXERS USED WITH MODEL 1772 LOCAL-OSCILLATOR FREQUENCY MULTIPLIER

CHAPTER 4
CABLING

4.1 GENERAL

The characteristics of the mixer-to-receiver interconnecting cables are of importance when operating the receiver over the complete frequency range.

Consideration must be given to the total attenuation between the output of the first local oscillator and input terminal of the mixer or low-frequency converter, as well as the loss of the RF input cables.

Major cable considerations are:

a. The cable used must have a 50Ω impedance to enable matching of the mixer to the receiver.

b. The cable must be either double-shielded or solid-sheathed to minimize both radiation and RF pickup.

c. Recommended low-VSWR, 50Ω connectors must be used to terminate the cable.

d. Never exceed the minimum cable bending radious recommended by the manufacturer.

e. Use only cable diameters recommended for conduction signals at frequencies including 2.5 GHz for Series 1710 Receivers and 4.1 GHz for all other Scientific-Atlanta instrumentation receivers.

4.2 LOW FREQUENCY RANGE

When evaluating the type and length of cable which may be used to provide satisfactory operation between the receiver and the antenna, the operational frequency range to be used is of major importance.

The low frequency converter for the Series 1700 Receivers may be operated remotely. The cable loss calculation in this case is the same as for the high frequency range, see paragraph 4.3.

The following discussion is for the case in which the low frequency converter is located at the receiver.

If the receiver is to be used over all or a portion of the low frequency range (see Table 1, Chapter 1),then the most critical factor concerning allowable cable attenuation is the loss of receiver sensitivity at the highest frequency to be used. The maximum sensitivity loss is equal to the total input cable attenuation at the highest frequency to be used.

Table 2 shows the loss per 100 feet for commonly used 50 ohm cables.

Any of the cables listed in Table 2 may be employed over the full low frequency range. All cables listed by Table 2 with the exception of the 1-5/8" Styroflex which has a cutoff frequency below 4.0 GHz may also be employed for high frequency receiver operation.

If sensitivity in the low frequency range is the major consideration, the total cable loss should be as small as possible. Table 3 lists the minimum size cables for various cable run lengths if the minimum loss at 1.95 GHz is to be in the order of 7.0 dB or less and operation of the high frequency receiver range is not considered.

TABLE 2

CABLE ATTENUATION OVER 20 MC TO 1.95 GHz FREQUENCY RANGE

Receiver Input Frequency	Double-Shielded Flexible Cable		Attenuation decibels per 100 feet Solid-Sheathed Semi-Flexible Styroflex Cable					
	RG-212/U	RG-214/U	3/8"	1/2"	3/4"	7/8"	1-1/8"	1-5/8"
20 Mc	1.2 dB	0.9 dB	0.51 dB	0.35 dB	0.23 dB	0.20 dB	0.15 dB	0.10 dB
50 Mc	2.2 dB	1.5 dB	0.8 dB	0.57 dB	0.37 dB	0.315 dB	0.28 dB	0.165 dB
100 Mc	2.95 dB	2.7 dB	1.12 dB	0.8 dB	0.52 dB	0.44 dB	0.34 dB	0.23 dB
250 Mc	5.0 dB	3.6 dB	1.8 dB	1.3 dB	0.85 dB	0.74 dB	0.57 dB	0.39 dB
500 Mc	7.4 dB	5.8 dB	2.6 dB	1.9 dB	1.25 dB	1.07 dB	0.84 dB	0.57 dB
1000 Mc	11.5 dB	8.9 dB	3.9 dB	2.8 dB	1.85 dB	1.57 dB	1.25 dB	0.89 dB
1500 Mc	14.0 dB	11.5 dB	4.9 dB	3.5 dB	2.35 dB	2.0 dB	1.6 dB	1.12 dB
1950 Mc	17.5 dB	13.5 dB	5.8 dB	4.2 dB	2.8 dB	2.4 dB	1.95 dB	1.4 dB

Table 3 shows losses between 6.0 dB and 7.0 dB at 1.95 GHz for cable runs of 200 feet and longer. This attenuation can be further reduced by substituting Styroflex cable for a portion of the flexible RG-214/U cable run.

4.3 HIGH FREQUENCY RANGE

When using the high frequency receiver RF range the receiver input cable connects an external mixer to the receiver and the attenuation of the first local oscillator signal and the IF signal must be considered. Since the cable attenuation at 65 MHz or 45 MHz is relatively small compared to the attenuation at the highest local oscillator frequency (4.1 GHz or 2.5 GHz), the receiver sensitivity will be primarily affected by excessive attenuation of the local oscillator signal.

The attenuation permissible at 4.1 GHz or 2.5 GHz between the receiver RF INPUT connector and the remote mixer input connector is determined by the difference in level of the local oscillator available at the receiver RF INPUT connector and the minimum power level required for proper mixer drive. The local-oscillator power available at the RF INPUT connector is given in Table 1.

As a general rule a minimum local-oscillator power level of 10 mW (+10 dBm) at the mixer input connector is necessary for efficient high order harmonic mixing. See Chapter 1 for additional information on local oscillator power requirements.

When determining cable loss, the loss of cabling in a console assembly must be included as a portion of the maximum loss. Table 4 shows cable types recommended for standard distances between the mixer input terminal and the receiver High Frequency RF INPUT connector.

TABLE 3

RECOMMENDED CABLES VERSUS CABLE LENGTH FOR LOW FREQUENCY RANGE

Total Cable Run Length	Double Shielded Flexible Cables			Solid Shield Semi-Flexible Styroflex Cable			Total Cable Atten. At 1.95 GHz
	Total Number	Total Length	Cable Type	Length	Outer Diameter	Min. Bend Radius	
15'	1	15'	RG-212/U	--	--	--	2.6 dB
25'	1	25'	RG-212/U	--	--	--	3.38 dB
50'	2	12'	RG-214/U	38'	3/8"	4"	3.83 dB
75'	2	12'	RG-214/U	63'	1/2"	5"	4.27 dB
100'	2	12'	RG-214/U	88'	1/2"	5"	5.32 dB
150'	2	12'	RG-214/U	138'	3/4"	7.5"	5.48 dB
200'	2	12'	RG-214/U	188'	7/8"	10"	6.13 dB
250'	2	12'	RG-214/U	238'	1-1/8"	17"	6.26 dB
300'	2	12'	RG-214/U	288'	1-5/8"	25"	5.67 dB
350'	2	12'	RG-214/U	338'	1-5/8"	25"	6.3 dB
400'	2	12'	RG-214/U	388'	1-5/8"	25"	7.06 dB

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The specific cable lengths and types recommended by Table 4 can only serve as a design guide for any specific application. If the application requires economy, and higher loss over the low frequency range if acceptable, then the long interconnecting cable which should be selected is the cable which has the greatest attenuation at 4.1 GHz but does not attenuate the 4.1 GHz local oscillator signal excessively. If the application requires a very low loss at 1.95 GHz then a more expensive cable should be selected to reduce the overall attenuation.

TABLE 4 RECOMMENDED HIGH FREQUENCY RANGE CABLING

Total Distance Receiver RF INPUT Connector to Mixer Input Con.	Provision For Console Cabling		Provision For Flexible Terminating Cables		Styroflex Solid Sheath Cables			Total Cable Atten at IF	Total Cable Atten at 4.1 GHz	Total Cable Atten at 1.95 GHz
	Cable Length	Cable Type	No. of Cables	Total Cable Length-Type	Total Length	Outer Dia.	Bend Radius			
15'	--	--	1	15' RG-212/U	--	--	--	0.4 dB	4.1 dB	2.6 dB
15'	6'	RG-212/U	1	15' RG-212/U	--	--	--	0.5 dB	5.7 dB	3.7 dB
50'	--	--	1	50' RG-214/U	--	--	--	0.9 dB	11.0 dB	6.8 dB
56'	6'	RG-214/U	1	50' RG-214/U	--	--	--	0.9 dB	11.54 dB	7.1 dB
75'	--	--	2	25' RG-214/U	50'	3/8"	4"	0.9 dB	10.0 dB	6.3 dB
81'	6'	RG-214/U	2	25' RG-214/U	50'	3/8"	4"	1.0 dB	11.32 dB	7.03 dB
100'	--	--	2	25' RG-214/U	75'	1/2"	5"	0.9 dB	9.53 dB	5.45 dB
100'	6'	RG-214/U	2	25' RG-214/U	75'	1/2"	5"	1.0 dB	10.85 dB	7.26 dB
125'	--	--	2	25' RG-214/U	100'	3/4"	7.5"	0.9 dB	10.0 dB	6.13 dB
131'	6'	RG-214/U	2	25' RG-214/U	100'	3/4"	7.5"	1.0 dB	11.3 dB	6.94 dB
225'	--	--	2	25' RG-214/U	200'	7/8"	10"	1.2 dB	13.5 dB	8.18 dB
231'	6'	3/8" Styroflex	2	25' RG-214/U	200'	7/8"	10"	1.2 dB	14.0 dB	8.5 dB
268'	--	--	2	18' RG-214/U	250'	7/8"	10"	1.0 dB	13.96 dB	8.4 dB
274'	6'	3/8" Styroflex	2	18' RG-214/U	250'	7/8"	10"	1.1 dB	14.5 dB	8.77 dB
318'	--	--	2	18' RG-214/U	300'	1-1/8"	17"	1.1 dB	13.9 dB	8.13 dB
324'	6'	1/2" Styroflex	2	18' RG-214/U	300'	1-1/8"	17"	1.2 dB	14.26 dB	8.38 dB
368'	--	--	2	18' RG-214/U	350'	1-1/8"	17"	1.2 dB	13.7 dB	7.95 dB
374'	6'	1/2" Styroflex	2 2	6' RG-214/U 12' 1/2" Styroflex	350'	1-1/8"	17"	1.2 dB	14.1 dB	8.2 dB
418'	--	--	2 2	6' RG-214/U 12' 3/4" Styroflex	400'	1-1/8"	17"	1.3 dB	15 dB	8.74 dB
400'	6'	1/2" Styroflex	2 2	6' 3/8" Styroflex 12' 3/4" Styroflex	400'	1-1/8"	17"	1.3 dB	15.4 dB	8.9 dB

* The cables listed above have been selected to provide adequate local oscillator power at the remote mixer and to maintain a moderate attenuation to 1950 Mc.

CONVERSION OF VOLTAGE AND POWER RATIOS TO DECIBELS

The basic chart below indicates the number of decibels (dB) corresponding to the listed ratios of voltage or power over the range of −20 to +20 dB. For voltage or power ratios greater than those included in the chart, the ratio can be broken down into a product of two numbers, the value in dB for each found separately, and the two results added. Example: To convert a power ratio of 2,000:1 to dB, express 2,000 as 2×10^3; the number of dB corresponding to a power ratio of 2 is very nearly 3, and the number of dB for a power ratio of 10^3 is 30. Therefore, the power ratio of 2,000:1 is approximately 30 dB + 3 dB = 33 dB. In the lower righthand corner of the chart dB values for voltage and power ratios of integral powers of 10 are given.

Voltage Ratio	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*
1.000	**1.000**	**0**	**1.000**	**1.000**	**.447**	**.200**	**7.0**	**2.239**	**5.012**	**.200**	**.0398**	**14.0**	**5.012**	**25.12**
.989	.977	.1	1.012	1.023	.442	.195	7.1	2.265	5.129	.197	.0389	14.1	5.070	25.70
.977	.955	.2	1.023	1.047	.437	.191	7.2	2.291	5.248	.195	.0380	14.2	5.129	26.30
.966	.933	.3	1.035	1.072	.432	.186	7.3	2.317	5.370	.193	.0372	14.3	5.188	26.92
.955	.912	.4	1.047	1.096	.427	.182	7.4	2.344	5.495	.191	.0363	14.4	5.248	27.54
.944	.891	.5	1.059	1.122	.422	.178	7.5	2.371	5.623	.188	.0355	14.5	5.309	28.18
.933	.871	.6	1.072	1.148	.417	.174	7.6	2.399	5.754	.186	.0347	14.6	5.370	28.84
.923	.851	.7	1.084	1.175	.412	.170	7.7	2.427	5.888	.184	.0339	14.7	5.433	29.51
.912	.832	.8	1.096	1.202	.407	.166	7.8	2.455	6.026	.182	.0331	14.8	5.495	30.20
.902	.813	.9	1.109	1.230	.403	.162	7.9	2.483	6.166	.180	.0324	14.9	5.559	30.90
.891	**.794**	**1.0**	**1.122**	**1.259**	**.398**	**.159**	**8.0**	**2.512**	**6.310**	**.178**	**.0316**	**15.0**	**5.623**	**31.62**
.881	.776	1.1	1.135	1.288	.394	.155	8.1	2.541	6.457	.176	.0309	15.1	5.689	32.36
.871	.759	1.2	1.148	1.318	.389	.151	8.2	2.570	6.607	.174	.0302	15.2	5.754	33.11
.861	.741	1.3	1.161	1.349	.385	.148	8.3	2.600	6.761	.172	.0295	15.3	5.821	33.88
.851	.724	1.4	1.175	1.380	.380	.145	8.4	2.630	6.918	.170	.0288	15.4	5.888	34.67
.841	.708	1.5	1.189	1.413	.376	.141	8.5	2.661	7.079	.168	.0282	15.5	5.957	35.48
.832	.692	1.6	1.202	1.445	.372	.138	8.6	2.692	7.244	.166	.0275	15.6	6.026	36.31
.822	.676	1.7	1.216	1.479	.367	.135	8.7	2.723	7.413	.164	.0269	15.7	6.095	37.15
.813	.661	1.8	1.230	1.514	.363	.132	8.8	2.754	7.586	.162	.0263	15.8	6.166	38.02
.804	.646	1.9	1.245	1.549	.359	.129	8.9	2.786	7.762	.160	.0257	15.9	6.237	38.90
.794	**.631**	**2.0**	**1.259**	**1.585**	**.355**	**.126**	**9.0**	**2.818**	**7.943**	**.159**	**.0251**	**16.0**	**6.310**	**39.81**
.785	.617	2.1	1.274	1.622	.351	.123	9.1	2.851	8.128	.157	.0246	16.1	6.383	40.74
.776	.603	2.2	1.288	1.660	.347	.120	9.2	2.884	8.318	.155	.0240	16.2	6.457	41.69
.767	.589	2.3	1.303	1.698	.343	.118	9.3	2.917	8.511	.153	.0234	16.3	6.531	42.66
.759	.575	2.4	1.318	1.738	.339	.115	9.4	2.951	8.710	.151	.0229	16.4	6.607	43.65
.750	.562	2.5	1.334	1.778	.335	.112	9.5	2.985	8.913	.150	.0224	16.5	6.683	44.67
.741	.550	2.6	1.349	1.820	.331	.110	9.6	3.020	9.120	.148	.0219	16.6	6.761	45.71
.733	.537	2.7	1.365	1.862	.327	.107	9.7	3.055	9.333	.146	.0214	16.7	6.839	46.77
.724	.525	2.8	1.380	1.905	.324	.105	9.8	3.090	9.550	.145	.0209	16.8	6.918	47.86
.716	.513	2.9	1.396	1.950	.320	.102	9.9	3.126	9.772	.143	.0204	16.9	6.998	48.98
.708	**.501**	**3.0**	**1.413**	**1.995**	**.316**	**.100**	**10.0**	**3.162**	**10.000**	**.141**	**.0200**	**17.0**	**7.079**	**50.12**
.700	.490	3.1	1.429	2.042	.313	.0977	10.1	3.199	10.23	.140	.0195	17.1	7.161	51.29
.692	.479	3.2	1.445	2.089	.309	.0955	10.2	3.236	10.47	.138	.0191	17.2	7.244	52.48
.684	.468	3.3	1.462	2.138	.306	.0933	10.3	3.273	10.72	.137	.0186	17.3	7.328	53.70
.676	.457	3.4	1.479	2.188	.302	.0912	10.4	3.311	10.96	.135	.0182	17.4	7.413	54.95
.668	.447	3.5	1.496	2.239	.299	.0891	10.5	3.350	11.22	.133	.0178	17.5	7.499	56.23
.661	.437	3.6	1.514	2.291	.295	.0871	10.6	3.388	11.48	.132	.0174	17.6	7.586	57.54
.653	.427	3.7	1.531	2.344	.292	.0851	10.7	3.428	11.75	.130	.0170	17.7	7.674	58.88
.646	.417	3.8	1.549	2.399	.288	.0832	10.8	3.467	12.02	.129	.0166	17.8	7.762	60.26
.638	.407	3.9	1.567	2.455	.285	.0813	10.9	3.508	12.30	.127	.0162	17.9	7.852	61.66
.631	**.398**	**4.0**	**1.585**	**2.512**	**.282**	**.0794**	**11.0**	**3.548**	**12.59**	**.126**	**.0159**	**18.0**	**7.943**	**63.10**
.624	.389	4.1	1.603	2.570	.279	.0776	11.1	3.589	12.88	.125	.0155	18.1	8.035	64.57
.617	.380	4.2	1.622	2.630	.275	.0759	11.2	3.631	13.18	.123	.0151	18.2	8.128	66.07
.610	.372	4.3	1.641	2.692	.272	.0741	11.3	3.673	13.49	.122	.0148	18.3	8.222	67.61
.603	.363	4.4	1.660	2.754	.269	.0724	11.4	3.715	13.80	.120	.0145	18.4	8.318	69.18
.596	.355	4.5	1.679	2.818	.266	.0708	11.5	3.758	14.13	.119	.0141	18.5	8.414	70.79
.589	.347	4.6	1.698	2.884	.263	.0692	11.6	3.802	14.45	.118	.0138	18.6	8.511	72.44
.582	.339	4.7	1.718	2.951	.260	.0676	11.7	3.846	14.79	.116	.0135	18.7	8.610	74.13
.575	.331	4.8	1.738	3.020	.257	.0661	11.8	3.890	15.14	.115	.0132	18.8	8.710	75.86
.569	.324	4.9	1.758	3.090	.254	.0646	11.9	3.936	15.49	.114	.0129	18.9	8.811	77.62
.562	**.316**	**5.0**	**1.778**	**3.162**	**.251**	**.0631**	**12.0**	**3.981**	**15.85**	**.112**	**.0126**	**19.0**	**8.913**	**79.43**
.556	.309	5.1	1.799	3.236	.248	.0617	12.1	4.027	16.22	.111	.0123	19.1	9.016	81.28
.550	.302	5.2	1.820	3.311	.246	.0603	12.2	4.074	16.60	.110	.0120	19.2	9.120	83.18
.543	.295	5.3	1.841	3.388	.243	.0589	12.3	4.121	16.98	.108	.0118	19.3	9.226	85.11
.537	.288	5.4	1.862	3.467	.240	.0575	12.4	4.169	17.38	.107	.0115	19.4	9.333	87.10
.531	.282	5.5	1.884	3.548	.237	.0562	12.5	4.217	17.78	.106	.0112	19.5	9.441	89.13
.525	.275	5.6	1.905	3.631	.234	.0550	12.6	4.266	18.20	.105	.0110	19.6	9.550	91.20
.519	.269	5.7	1.928	3.715	.232	.0537	12.7	4.315	18.62	.104	.0107	19.7	9.661	93.33
.513	.263	5.8	1.950	3.802	.229	.0525	12.8	4.365	19.05	.102	.0105	19.8	9.772	95.50
.507	.257	5.9	1.972	3.890	.227	.0513	12.9	4.416	19.50	.101	.0102	19.9	9.886	97.72
.501	**.251**	**6.0**	**1.995**	**3.981**	**.224**	**.0501**	**13.0**	**4.467**	**19.95**	**.100**	**.0100**	**20.0**	**10.000**	**100.00**
.496	.246	6.1	2.018	4.074	.221	.0490	13.1	4.519	20.42					
.490	.240	6.2	2.042	4.169	.219	.0479	13.2	4.571	20.89	10^{-2}	10^{-3} 10^{-4}	30 40	10^{2}	10^{3} 10^{4}
.484	.234	6.3	2.065	4.266	.216	.0468	13.3	4.624	21.38					
.479	.229	6.4	2.089	4.365	.214	.0457	13.4	4.677	21.88		10^{-5}	50		10^{5}
										10^{-3}	10^{-6}	60	10^{3}	10^{6}
.473	.224	6.5	2.113	4.467	.211	.0447	13.5	4.732	22.39		10^{-7}	70		10^{7}
.468	.219	6.6	2.138	4.571	.209	.0437	13.6	4.786	22.91	10^{-4}	10^{-8}	80	10^{4}	10^{8}
.462	.214	6.7	2.163	4.677	.207	.0427	13.7	4.842	23.44		10^{-9}	90		10^{9}
.457	.209	6.8	2.188	4.786	.204	.0417	13.8	4.898	23.99					
.452	.204	6.9	2.213	4.898	.202	.0407	13.9	4.955	24.55	10^{-5}	10^{-10}	100	10^{5}	10^{10}
											10^{-11}	110		10^{11}
										10^{-6}	10^{-12}	120	10^{6}	10^{12}

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